D R A F T
for discussion purposes only

California Education and the Environment Initiative

ACKNOWLEDGEMENTS

The EEI Curriculum was developed as a cooperative endeavor of the following agencies:

California Environmental Protection Agency
California Integrated Waste Management Board
California Department of Education
California State Board of Education
Office of the Secretary of Education
California Resources Agency

Project Managers for the Education and the Environment Initiative were:

Andrea Lewis, Assistant Secretary
Cal/EPA

Mindy Fox, Director
Office of Education and the Environment
California Integrated Waste Management Board

Funding for the development of this curriculum was provided through the generous support of the California Integrated Waste Management Board.

Additional funding has been provided by:
California Energy Commission and the State Water Resources Control Board.

CONTRIBUTORS

Author: **Michael Roa**
California Connections Author: **Lori Mann**
Principal Consultant: **Dr. Gerald A. Lieberman, Director, State Education and Environment Roundtable**
Managing Editor: **Jennifer Rigby, Director, The Acorn Group**
Instructional Editors: **Grace Lieberman and Jayne Henn**
Copy Editors: **Lori Mann and Laurel Singleton**
Photo Editors: **Roni Java, Kip Evans and Aleta Zak**
Graphic Design: **Karol A. Keane**

Office of Education and the Environment
1001 I Street, 13th Floor
Sacramento, California 95812
(916) 341-6769

http://www.calepa.ca.gov/Education/EEI/

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Overview

Students know there are many different types of organisms in the world. They may not have considered how those organisms make their livings; that is, how they obtain the food they need to maintain their bodies. As students learn about organisms, one of the first topics they study is their function in the environment or ecosystem—how they make their livings. In this unit, Energy—Pass it On!, students learn about the roles populations of organisms fill in ecosystems.

Humans are among the organisms that influence Earth's ecosystems and other organisms living within them. Human actions influence the health and functioning of ecosystems; conversely, we are dependent upon ecosystems for our food and the materials that we consume. We are part of the ecosystems in which we live and from which we obtain materials—and into which we release the byproducts of our activities.

By learning about the functions of organisms within an ecosystem, students gain an understanding of how all living things, including humans, depend on both the physical environment and the interactions among organisms. The lessons in

At a Glance

What Is a Population?
Explore the term population through the eyes of California wolverines.

Making a Living
Discover functions of organisms in the Sierra Nevada mountains.

The Higher the Fewer
Investigate energy flow is an ecosystem.

California Content Standard

6.5. Organisms in ecosystems exchange energy and nutrients among themselves and with the environment.

6.5.c. Students know populations of organisms can be categorized by the functions they serve in an ecosystem.

California Environmental Principle IV

The exchange of matter between natural systems and human societies affects the long-term functioning of both.

Concept A: Students need to know that the effects of human activities on natural systems are directly related to the quantities of resources consumed and to the quantity and characteristics of the resulting byproducts.

Concept B: Students need to know that the byproducts of human activity are not readily prevented from entering natural systems and may be beneficial, neutral, or detrimental in their effect.

this unit explore three related ecological ideas: what a population is, how populations function, and how energy and materials are transferred through ecosystems. In addition, the lessons explore the role of humans as consumers in ecosystems, which helps students understand our place in the environment. As students learn ways in which humans depend on ecosystems, they begin to understand ways we influence the natural systems upon which we depend.

Through California Connections: Where Are the Wolverines? in Lesson 1, students learn about wolverines in the Sierra Nevada Mountains and are introduced to the meaning of the term "population." Lesson 2 focuses on the main functions that organisms serve in ecosystems, especially the ways in which they obtain food. Lesson 3 addresses the loss of energy at each trophic level. Lesson 4 discusses changes in forest ecosystems and some of the effects that human activities have on the forest environment. Students return to the Where Are the Wolverines? in Lesson 5 to learn that changes in ecosystems do not necessarily have just one cause. The final lesson uses a persuasive essay writing assignment as an opportunity for students to apply their understanding that issues, including issues relating to natural and human interactions, have more than one side.

It Is All Connected
Discuss how ecosystem changes affect energy flow.

Cause and Effect?
Investigate how people influence energy flow in ecosystems.

Making Choices: The Effects of Human Consumption
Examine how human use of natural resources influences ecosystems.

Where Are the Wolverines?

Wolverines once roamed the Sierra Nevada Mountains. However, nobody has seen one in California since 1953. Today, most scientists believe the mammal either no longer lives in the state, or is very rare. What happened to California's wolverines?

With thick bushy coats, broad heads, and short furry ears, wolverines look like small black bears. Along with their sharp teeth and claws, they use foul-smelling musk oil to defend themselves. The musk oil makes them smell like a skunk. These features earned the wolverine the nickname of "skunk bear."

Wolverines eat many kinds of foods. Their prey includes hoary marmots, mice, gophers, deer, and pikas. Pikas are small rabbit-like animals that live at high elevations. Wolverines are both carnivores and scavengers. Carnivores kill and eat meat. Scavengers feed on dead animals, also called carrion. Carrion is an especially important part of the wolverine's diet in winter.

Wolverines are about the size of a small collie. They are the largest member of the weasel family. They are also the most ferocious. Wolverines are remarkably strong for their size. They have been known to kill animals as large as a moose. Their powerful jaws and sharp claws make them powerful predators. Their teeth are sharp and strong enough to chew through bone and carrion that has frozen in the snow.

What wolverines lack in size, they make up for with aggressiveness. A large wolverine might weigh only 40 pounds. But it will challenge much larger predators and steal their prey. Hunters and trappers have witnessed 1,000-pound grizzly bears leaving their meals behind when a wolverine approaches.

Wolverines normally live high in the mountains. They usually are found in high open areas where it is too cold and snowy for trees to grow. Wolverines share their habitat with populations of other small- and medium-size mammals, birds, insects, and fungi that they hunt and eat. Other, larger predators like mountain lions, bears, and wolves also live in the same region. These predators compete with wolverines for food.

Wolverines are well adapted to live and hunt in the snow. Their fur is thick and keeps them warm. Their feet are large so they can walk easily on snow. If they are hungry, they can even use their long claws to dig 10 feet into the snow to find hibernating animals.

Snow plays a very important role in wolverine survival. Female wolverines raise their babies in dens built in deep snow layers. These dens are long, complex snow tunnels that protect the young from predators and provide warmth in the cold climate. If there is not enough snow, wolverine babies may not survive to adulthood.

Caption to come

Two things help determine the size of the territory each wolverine needs. One is having adequate sources of food. The other is being able to find a suitable place for a den. Wolverines cover many miles in a day of hunting. Each animal needs lots of space to hunt and raise its young. Wolverines fight off other wolverines that try to enter their home territory. This limits the total number of wolverines that might live in a region. It is one of the reasons that wolverines are considered one of the rarest mammals in North America.

While wolverine numbers were never very high, there were enough around in the 1800s that trappers considered them pests. Trappers would lose money when hungry wolverines stole animals from their traps. The trappers used poisoned bait to kill wolverines.

Early settlers reported wolverines stealing food from their cabins. The "skunk bears" sometimes ruined settlers' belongings with their musk and urine marking. Wolverines were considered particularly fierce and dangerous animals. They were often killed when the opportunity arose.

Because wolverines are very secretive and travel across huge ranges, they are hard for scientists to study. Many things about the species are not known. But one thing is sure. Wolverines used to live throughout the higher reaches of the Sierra Nevada Mountains. Now they are exceedingly rare. Their decline is a mystery scientists want to explore.

Where Are the Wolverines?—Part 2

While wolverines are no longer seen in California they are believed to still live here. Scientists set out to explore why they have become so rare. Since wolverines need snow for their dens, a drop in snow levels could explain the decline. A decrease in the population of their prey species might also explain the lack of wolverines. So scientists have studied weather patterns and prey populations over the past 150 years. The studies have shown that climate and prey populations have not changed much. Food shortages and lack of snow are not believed to have caused the decline of the wolverine.

What has changed over the last 150 years? For one thing, the ways people use the land have changed a lot. The discovery of gold at Sutter's Mill in

Caption to come

1848 began a major shift in the region. Is this what caused the wolverine to vanish?

After the Gold Rush started, miners and early settlers built many new towns in the Sierra Nevada Mountains. In 1860, about 150,000 people lived in the region. By 1960, that number grew to around 275,000. The population reached 650,000 in 1990 and will soon pass 1,000,000.

The Gold Rush paved the way for many new industries. In lower elevations, forests were cut to provide lumber for mines and houses. By 1880, over 1.5 million acres of pine forests had been cleared. Different kinds of trees grow at higher elevations. The lumber from these trees is not as good for building, so there was not as much logging in the areas where wolverines generally lived.

Gold Rush mining practices caused huge amounts of soil to wash into mountain streams. This changed the ways the rivers flowed. Farmers also used a lot of water. They took it from streams to water, or irrigate, their crops. In fact, they used more land for farming and ranching in 1860 than in any year since. Irrigation projects continued to grow until the 1920s. They have leveled off since then.

Cattle grazing was common at lower elevations. In the higher grasslands where wolverines lived, ranchers grazed sheep. This practice cleared huge areas of native grasses in the late 1800s. Ranchers worried about wolverines that hunted and killed their livestock. Like trappers, they also poisoned wolverines when they became a threat to ranchers' income.

Parks were created at Yosemite Valley and Calaveras Big Trees in the 1860s. These were the first parks in the Sierra Nevada Mountains. More parks followed. Tourism brought more people to the area. More people meant more contact with wolverines. Some people were afraid of wolverines and sometimes killed them to protect themselves.

The development of mining, grazing, farming, logging, and recreation all affected the habitat of the wolverine. Finding places to build dens and raise young became difficult. The predators no longer had unbroken home ranges in which to hunt. As their habitat changed, the numbers of some prey species, like the pika, also decreased. Hunters killed deer, reducing an important winter food source for the wolverines. It grew harder and harder for the wolverine population to maintain its historical size in the Sierra Nevada Mountains.

The mystery is solved. No one thing caused wolverines to disappear from California's mountains. A combination of factors contributed to the population decline.

Background

Caption to come

While students may have heard the term population they probably have heard it used in the context of numbers of people. They may have heard the population of California is X, or the population of the United States is Y.

It is implicit in such statements of population that they refer to the number of humans currently living in the place.

In scientific studies, the term **population** has a somewhat different meaning. Understanding the scientific meaning of population and that all organisms exist as populations helps students to understand that people are part of an ecosystem and that we are governed by the same natural laws as other organisms.

In ecological studies, the term population applies to the number of a particular species in a place at a particular time, or the members of a species in a place. Examples of statements of populations might be:

- Two hundred fifty perch were in the pond last summer.
- Seventy-five field mice lived in the meadow last week.
- One hundred fifty oak trees were in the valley before the fire.
- The entire deer population left after the houses were built.
- The population of raccoons in the nearby forest became a problem when they discovered the trash cans.

Studying populations of organisms enables ecologists to understand the roles that both individuals and groups of individuals play in ecosystems.

Caption to come Obor ipit iriure modions equisl iliquate ex er se del utat. Onum nulputat,

The activities in this unit help the students understand the scientific use of the term population and the ways that human populations interact with other organisms in ecosystems.

To facilitate discussion of organisms and their functions in ecosystems, scientists have given names to the various roles or functions that organisms serve. Plants and algae are called **producers** because they use simple chemicals such as carbon dioxide and water, and energy from the sun, to produce complex chemicals such as sugars and starches through the process of **photosynthesis**. The organism then uses the sugars and starches as a source of energy. Oxygen is given off as a byproduct of photosynthesis.

Some forms of bacteria use chemicals and energy from volcanic vents deep in the ocean or in areas such as Yellowstone National Park to produce complex chemicals through the process of chemosynthesis. The emphasis in this unit, however, is on the more common photosynthetic organisms.

Organisms that feed on other organisms are called **consumers**. They consume or feed on other organisms, thereby obtaining the materials they need to build and maintain their bodies and the energy they require to live. Some consumers (herbivores) feed primarily on plants. Others (carnivores) feed primarily on other animals. Omnivores are consumers that feed on both plants and animals. Some consumers eat or consume their food in its entirety, while others, such as mosquitoes, ticks, or other parasites feed on their hosts without killing them.

Decomposers obtain their nutrients by producing chemicals called enzymes that digest already dead organisms. Decomposers return nutrients to the environment, thereby enabling plants to live. Without the actions of decomposers, nutrients would remain tied up in dead organisms and unavailable to plants. Earth also would be littered with dead bodies! Bacteria and fungi are common decomposers.

Feeding is the transfer of energy and materials from one organism to another. This transfer can be seen as a series of steps, often represented as a **food chain**. Food chains follow the path as one organism eats another.

The steps in a food chain are referred to as **trophic levels**. Organisms that eat plants are called herbivores and are first trophic level consumers or **primary consumers**. Animals that eat other animals are called carnivores and are second trophic level consumers or **secondary consumers**. Other carnivores may eat second level consumers and are called third level or **tertiary consumers**, and so on. The last carnivore in the chain is called the top carnivore.

Here is an example of one food chain: grass (producer) eaten by grasshopper (herbivore, first trophic level), eaten by a frog (first carnivore, second trophic level), eaten by a snake (second carnivore, third trophic level), eaten by a hawk (top carnivore, fourth trophic level).

Of course, plants and animals are eaten by more than one kind of organism. In the ecosystem above, deer, rabbits, and birds might also eat the grass. A bird or lizard might eat the grasshopper, and a water bird such as an egret or a fish might eat the frog. The hawk might eat mice or gophers in addition to the snake. A diagram of such complex feeding patterns would produce a **food web**. A food web represents these relationships more realistically and shows how plants and animals are connected in ways that help them survive. Organisms use energy in the process of living. So, not all energy that enters one organism is available to the organism(s) that feed on it. Some of the energy is used in metabolic processes like digestion of food and elimination of wastes. Some energy

Caption to come

Caption to come

is used for such things as movement, and much chemical energy remains in waste products that are eliminated by organisms. Thus, as the energy passes through the trophic levels in a food chain or web, most is lost to the environment, primarily as heat. Less energy is available to the organisms at each **trophic level**.

The same general principle applies to the foods that humans consume. Some is added to our bodies as we grow and as we replace cells that die, but most of the matter that we take in as food is eliminated from our bodies. If this were not true, every ounce of food that we consume would stay on our bodies.

An **energy pyramid** illustrates how the amount of energy varies at different trophic levels. An energy pyramid has a wide base, with lots of energy (from the sun) available to producers. Less energy is available for the herbivores that feed on the plants, and still less for the first carnivores. At each step in a food chain, less energy is available for the next organisms. Thus, a broad base (lots of energy) tapers to a small top, with only a small fraction of the original energy available to the top carnivore (the top of the pyramid). A commonly used estimate is that 10% of the energy at a given trophic level is available for the next level, but this is a rough approximation. The more steps in the food chain, the smaller the percentage of energy available to the top carnivore.

Pyramids can also be used to show the relative numbers and masses of organisms at various trophic levels in an ecosystem.

Since all animals depend on producers for their food, either directly or indirectly, they are called consumers. Humans, therefore, are consumers. We consume food resources and other things produced by natural systems.

Human use and consumption of resources from natural systems influence the environment in many ways including the production of byproducts. Byproducts are incidental products created as the result of chemical reactions or manufacturing processes. They can be physical things, such as garbage or pollutants. Byproducts can also be excess heat energy released during the production of electricity.

The byproducts of human practices influence the transfer of matter through natural systems. For example, when trees are cut for lumber products, tree limbs and tops are generally left in the forest, where they may be a fire hazard or they may be compressed to form erosion-reducing ground cover. Bark and mill trimmings can be burned as waste, burned to produce usable heat energy, or used for such products as compressed wood fireplace logs, chip board, or garden mulch. Silt, released into streams when soil is exposed at a logging site, can interfere with salmon or trout spawning or raise the water level,

resulting in flooding and the erosion of stream banks.

As we learn more about ecological interactions of organisms and their environment, we also learn about the byproducts of our own actions. The logging examples above illustrate how the quantities of resources consumed and the quantity and characteristics of the resulting byproducts can affect natural systems. This can be important information when making resource management decisions.

When part of an ecosystem is altered in a significant way, the entire ecosystem is affected. This is true whether the ecosystem is changed by natural forces such as a fire, avalanche, drought, or flood, or by humans for agriculture, building, logging, or other purposes. Logging a hillside, for example, obviously affects the hillside ecosystem but also may affect fish and other animals far downstream. If siltation caused by that logging results in the loss of salmon from a major stream, it may ultimately affect marine life hundreds of miles away, such as seals that feed on the salmon. If trees or other vegetation grow back on the logged hillside, it may take many years for the streams to again be suitable for salmon spawning and still more years for a population of salmon to rebuild. Ecosystem alterations can have consequences for diverse populations that are far-reaching in both space and time.

Caption to come

Glossary

Consumer: An organism that obtains energy or matter from a natural system e.g., by eating other organisms.

Decomposer: An organism that obtains energy and matter by breaking down the remains of dead organisms.

Energy pyramid: A representation of the amount of energy available at different levels of a food chain.

Food chain: The sequence of feeding among organisms (e.g., mouse eating seed and in turn being eaten by an owl).

Food web: A complex pattern of several interacting food chains.

Photosynthesis: The process by which plants and algae convert light energy to chemical energy stored in carbohydrates.

Population: The number of individuals belonging to a species or several species living in a place at a given time.

Primary Consumer: In a food chain, the "first" consumer that obtains energy and matter by eating plants or algae.

Producer: An organism (plant or alga) that converts light energy to chemical energy stored in carbohydrates.

Secondary consumer: In a food chain, the "second" consumer that obtains energy and matter by eating a primary consumer.

Tertiary consumer: In a food chain, the "third" consumer that obtains energy and matter by eating a secondary consumer.

Trophic level: A step in the energy pyramid in which organisms obtain energy and matter in the same manner.

Unit Planner

	Lesson	Learning Objective(s)	At a Glance
1	**What Is a Population?**	■ Define a population.	Students compare and contrast the definitions of the term population as given by: (a) a dictionary, (b) their science text or teacher, (c) classmates and parents, and (d) background information provided in this lesson.
2	**Making a Living**	■ Give examples of the functions (producer, consumer, and decomposer) populations of organisms serve in an ecosystem. ■ Identify humans as consumers within ecosystem.	Students learn the functions of various organisms in the Sierra Nevada ecosystem. They learn terms scientists use, conduct research on the functions of organisms, and demonstrate their learning by completing a study guide identifying examples and answering questions about organisms and their functions in a specific ecosystem.
3	**The Higher, the Fewer**	■ Explain how energy is transferred in an ecosystem and how the amount of available energy varies at the level of consumption (primary, secondary, and tertiary consumers).	Students use energy pyramids and role-playing to learn about energy flow in a community. They start with 10,000 energy units, and as they read a script, they observe energy is lost at each trophic level in a food chain.
4	**It Is All Connected**	■ Identify and describe byproducts generated by the human consumption of goods (matter) produced by natural systems (ecosystems).	Students view before and after pictures of forested areas where human practices brought about changes. They discuss the changes in the ecosystems and the effects of those changes on the ecosystem. They also identify some of the unintended byproducts of logging practices.

Prerequisite Knowledge	Duration (minutes)	Materials Needed	Textbook Alignment
■ Students should be able to use a dictionary and understand that dictionaries often give several definitions for a word. ■ Students should understand the sixth grade science content standards 5.a. (energy transfer through photosynthesis and food chains) and 5.b. (food webs and decomposition).	**Preparation:** 15 min. **Instruction:** 60 min.	**Cardstock:** Six sheets **Editorial:** One newspaper editorial (that addresses a local land use issue, if possible) **String:** Six 3-foot lengths **Student dictionaries:** Approximately six per class **Class supplies:** Blank paper, colored pencils or crayons **Activity masters** **Visual aids**	**Glencoe:** Pages 552-559 **CPO:** Pages 300, 301, 307 **Harcourt:** Unit 5 Lessons 1-2 **Holt:** Pages 554, 555, 557-559, 570-573, 582-603, 608-611 **Houghton Mifflin:** Unit D Ch. 8: 294-297, 301, 308-315, 318-323, 326 **MacMillan:** Pages 36-37, 52-53, 66, 72, 77, 94-95, 119, 124, 127-129, 133, 146, 422 **Prentice Hall:** Chapters 10-11
■ Students know that energy entering ecosystems as sunlight is transferred by producers into chemical energy through photosynthesis and then from organism to organism through food webs. ■ Students know that matter is transferred over time from one organism to others in the food web and between organisms and the physical environment. ■ Students should be able to use books or the Internet to obtain information about biomes or ecosystems.	**Preparation:** 30 min. **Instruction:** 45 min.		
■ Students should know that energy entering ecosystems as sunlight is transferred by producers into chemical energy through photosynthesis and then from organism to organism through food chains and food webs. ■ Students should also know that matter is transferred over time from one organism to others in the food web and between organisms and the physical environment.	**Preparation:** 15-30 min. **Instruction:** 45 min.		
■ Students should understand that organisms are interdependent. They should be aware that food web relationships demonstrate the interdependence among organisms, and they should be able to identify examples of products made from wood logged in the Sierra Nevada Mountains	**Preparation:** 20 min. **Instruction:** 45 min.		

Unit Planner

	Lesson	Learning Objective(s)	At a Glance
5	**Cause and Effect?**	■ Describe the effects of human practices on the transfer of matter through natural systems.	Students read Where are the Wolverines?—Part 2. In groups, they review information about changes in the Sierras over the last 200 years, present summaries about causes and effects of environmental change, and discuss the difficulty in ascribing a given change to a single cause
6	**Making Choices: The Effects of Human Consumption**	■ Provide examples of how the quantities of resources consumed, and quantity and characteristics of the resulting byproducts can affect natural systems.	Students review realistic scenarios that propose changes in land use patterns. Working in pairs, students discuss both sides of their issue to develop an understanding of how use of resources affects natural systems. Then each student will write a persuasive essay, either supporting or opposing the proposed action.

Prerequisite Knowledge	Duration (minutes)	Materials Needed	Textbook Alignment
■ Students should understand that humans obtain many products from and engage in many uses of forests. Obtaining those products affects the environment in many ways, including the transfer of matter through natural systems. Students should be familiar with the natural history of the wolverine. (See Where are the Wolverines?—Part 1.)	**Preparation:** 15 min. **Instruction:** 45-60 min.	**Cardstock:** Six sheets **Editorial:** One newspaper editorial (that addresses a local land use issue, if possible) **String:** Six 3-foot lengths **Student dictionaries:** Approximately six per class **Class supplies:** Blank paper, colored pencils or crayons **Activity masters** **Visual aids**	**Glencoe:** Pages 552-559 **CPO:** Pages 300, 301, 307 **Harcourt:** Unit 5 Lessons 1-2 **Holt:** Pages 554, 555, 557-559, 570-573, 582-603, 608-611 **Houghton Mifflin:** Unit D Ch. 8: 294-297, 301, 308-315, 318-323, 326 **MacMillan:** Pages 36-37, 52-53, 66, 72, 77, 94-95, 119, 124, 127-129, 133, 146, 422 **Prentice Hall:** Chapters 10-11
■ Students should understand ways in which organisms depend upon their habitat for survival. They must be able to discuss ways that human changes in the environment can affect organisms. ■ Students should also understand that a persuasive essay is a form of a composition that: a. requires a clear position on a proposition, b. supports the position with organized and relevant evidence, and c. anticipates and addresses reader concerns and counter-arguments	**Preparation:** 15 min. **Instruction:** 90 min. (two 45-minute sessions)		

Differentiated Instruction & Extensions

Strategies for Below-Level Readers

When calling on students, allow time for processing. Let students discuss their answers with each other or with an aide before giving their final answer.

When definitions are called for (as in Lesson 1), provide direct instruction on the use of dictionaries or use simplified dictionaries (either in English or in foreign languages).

If students have trouble changing dictionary definitions into their own words, work with the class to develop a class definition.

Pair low-level readers with more advanced readers when assignments call for research.

In Lesson 3, have students read the

Strategies for Above-Level Readers

This unit introduces several vocabulary terms. Have students search for the terms (for example, "population," "consumer," "producer") in popular publications and compare how the terms are defined and used in these publications with the way they are defined and used in the unit. Students can lead a class discussion on the use of these words or present a written summary.

Have students conduct research using the Internet or other resources to extend their knowledge of populations of species discussed in this unit. Students can present their information orally, in writing, or as a poster.

Have students find data on how the population of a species has changed over time and graph the changes. Have them provide written explanations of their graphs, describing the changes in populations and the potential causes of the changes.

Extension Ideas

Select small study plots and have students investigate populations of specific organisms at various times of day or in different seasons. Students should develop tables for recording population data; record and graph data; write a brief explanation of each data set; and maintain the data and graphs for comparison in future years.

Have students build three-dimensional energy transfer models to represent the varying amounts of energy or matter represented at differ-

passage to themselves or with an aide before being asked to read aloud.

When working on written assignments, allow students to create illustrations and make an oral presentation about their assignment to the teacher or to an aide.

When brochures are produced, partner students with lower reading or writing skills with more able readers and writers. Provide written materials at appropriate levels, give extra time, or offer assistance of an aide.

Give students the option of making and using notes and practicing what they are going to say for oral presentations such as in Lesson 5. Ask students to summarize the text, (for example, "puzzle pieces") in their own words in writing and read their summary to the class.

In Lesson 6, have students dictate articles to an aide, volunteer, or parent and use this as the article they read to the class.

Ask students to investigate a local species that is threatened or endangered by attending a meeting where this species will be discussed. Students should investigate efforts to protect the species (for example, through habitat management, letters to the editor, fundraising) and present their findings to the class. (An Internet search should yield conservation organization names and contact information.)When reading the script in Lesson 3, have students create costumes or props to represent the characters.

Ask students to add text to the "The Energy Transfer Story: The Higher, the Fewer" script or create a new script.

Have students obtain, review, and report on (orally or in writing) actual Environmental Impact Reports or Timber Harvest Plans.

Ask students to investigate a local land use issue by conducting Internet research, visiting the specific site, attending hearings, and reading articles and editorials in local newspapers. Working with the teacher or a local volunteer, have students arrange for guest speakers for the class, prepare and ask questions, and write letters of appreciation. Students should write letters to the editor or create sample radio or television public service announcements about what they learn.

ent trophic levels.

Arrange a field trip to a park, forest, lumberyard, or hardware store to help students understand the importance of timber to humans and forest organisms. Invite guest speakers involved in the timber industry, forest management, or conservation to discuss their roles in resource management and use. Have students develop interview questions. Be sure students develop open-ended rather than closed questions. For example, rather than asking, "Were many trees cut here?" students should ask, "What are some of the effects of cutting trees in this area?" Have students practice their questioning skills with partners.

Traditional Assessment

Description:

The Energy - Pass It On! Unit Assessment is comprised of multiple choice and short answer questions. This test assesses student mastery of academic content standard 6.5.c. through each of the EEI Learning Objects addressed in this unit.

Instructions:

Teacher Instructions:
Distribute the copies of the Unit 6.5.c. Assessment (Unit Activity Masters) to the students and provide one class period to complete. The answer key is provided on page 19-20.

Suggested Scoring

Unit Assessment (Activity Master) I Answer Key *page 1 of 2*

Answers to multiple choice questions:

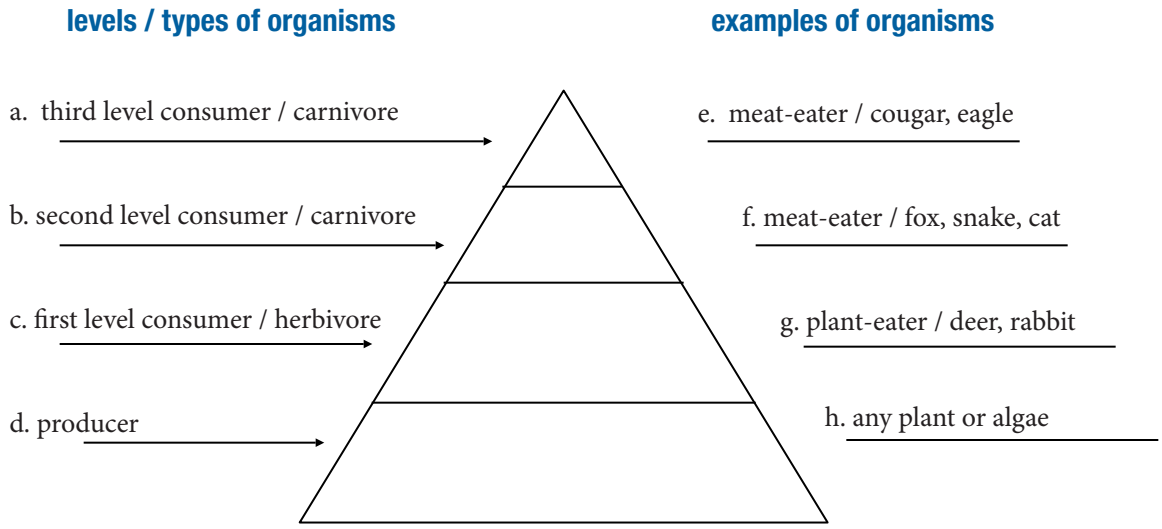
1. d 2. b 3. c 4. d 5. a 6. d 7. b 8. a 9. b 10. b 11. d 12. d 13. b

Possible answers to short answer questions:

14. **Sample Answer:** Producers such as plants use energy from the sun to form energy-rich chamicals such as sugars. This is done in the process of photosynthesis. Organisms that feed on other organisms are called consumers. Herbivores are consumers that obtain their energy by eating plants. Carnivores obtain their energy by eating other animals, which may include herbivores. A mountian lion might get its energy by eating a deer, which got its energy by eating plants, which got their energy from the sun through photosynthesis.

15. Label the trophic levels of the energy pyramid below. Use the following terms in your labels in the left column: (Some of lines a-d will have more than one term.)

Sample Answers:



16. If 100,000 units of energy are stored in the grass in the following food chain, how many units of energy would the hawk have?

Answer: The hawk would have 10 units of energy.

17. Explain why the hawk has less energy than is found in the grass.

Sample Answer: The hawk would have 10 energy units because only about 10% of the energy in a trophic level or step in an energy pyramid is available for the next level or step. This is because each organism uses some of the energy that it takes in, and much is lost to the environment as heat or in waste products rather than being passed on.

Grass=100,000 units, grasshoppers=10,000 units, frogs=1000 units, snakes=100 units, hawk=10 units.

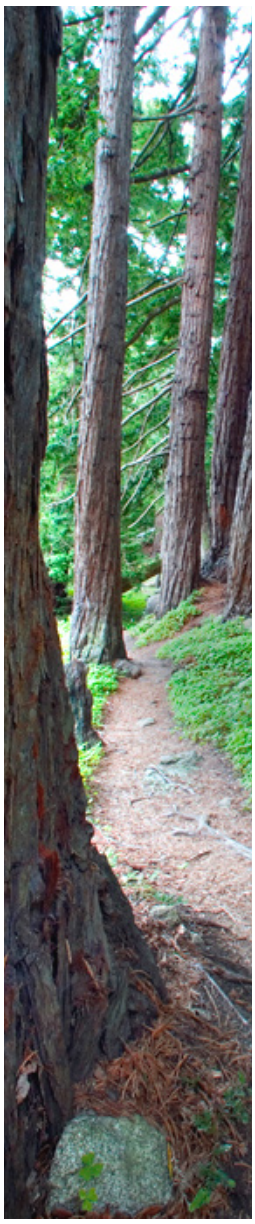
18. A city needs to widen the road going through a forest to a nearby lake. Name two parts of the road widening process that could affect the lake and forest ecosystem.

Sample Answer: the materials used in the widening of the road, how big (wide) the road is made to be, how long it takes to widen the road, cutting down trees and moving soil, exhaust, noise and vibrations from the machines used in widening the road, etc.

19. Could the widening of the road affect the food/energy pyramid in the lake or in the forest? Explain why or why not.

Sample Answer: The food/energy pyramid would be affected by the widening of the road, because as the forest and the lake are changed, the living organisms may be unable to locate food. Consumers in the forest might leave the area because of the noise and vibrations (scared away), or because their habitat is changed (tree was cut down, hillside was leveled). The consumers and scavengers that eat those consumers will also migrate (if they can) to another area, leaving the decomposers in the area with less "food." The organisms in the lake that are not able to migrate (fish, amphibians), if they are unable to find food, they will die. If the water in the lake changes (water level or water quality) because of soil erosion or use of the lake water by the road widening process, the plants could die, increasing the chances that the rest of the organisms in the lake will die.

Unit Resources



Resources for Students

California Institute for Biodiversity. *Cal Alive!* **http://www.calalive.org**

References for Teachers

Aubry, Keith B., Kevin S.McKelvey, and Jeffrey P. Copeland. In press. Geographic Distribution and Broad-Scale Habitat Relations of the Wolverine in the Contiguous United States. *Journal of Wildlife Management.*

Miller, G. Tyler, Jr. 2007. *Living in the Environment*, 15th ed. Belmont, CA: Brooks Cole Publishing.

Odum, Eugene, and Gary Barrett. 2005. *Fundamentals of Ecology*, 5th ed. Belmont, CA: Brooks Cole Publishing.

Sierra Nevada Ecosystem Project. 1996. *Sierra Nevada Ecosystem Project: Final Report to Congress.* Davis: University of California, Centers for Water and Wildland Resources. **http://ceres.ca.gov/snep/pubs/index.html**

Instructional Support

Agencies, institutions, and organizations throughout California have identified themselves as providing programs and materials that support this unit. Links to these resources are available at: **http://www.calepa.ca.gov/Education/EEI/instructional_support.html**